

## WHAT IS CLAIMED IS:

1           1.    For use in wireless network communications system  
2           comprising a base transceiver station having an adaptive  
3           antenna array and a mobile station having a first mobile  
4           antenna and a second mobile antenna, an apparatus for  
5           improving downlink performance of said adaptive antenna  
6           array of said base transceiver station, said apparatus  
          comprising:

          a spatial signature estimator associated with said  
          base transceiver station, said spatial signature estimator  
          capable of obtaining a spatial signature from a signal  
          received by said base transceiver station from said first  
          mobile antenna and that is capable of obtaining a spatial  
          signature from a signal received by said base transceiver  
          station from said second mobile antenna; and

          correlation circuitry coupled to said spatial  
          signature estimator, said correlation circuitry capable of  
          using spatial signatures obtained from said first mobile  
          antenna and from said second mobile antenna to identify a  
          least changing spatial signature, and capable of using said

least changing spatial signature to obtain a downlink beamforming weight vector.

2. The apparatus as set forth in Claim 1 wherein said spatial signature estimator is capable of obtaining a first set of spatial signatures comprising a first spatial signature from said first mobile antenna and a first spatial signature from said second mobile antenna during a first portion of an uplink interval of a time division duplex slot associated with said first mobile antenna and said second mobile antenna; and

wherein said spatial signature estimator is capable of obtaining a second set of spatial signatures comprising a second spatial signature from said first mobile antenna and a second spatial signature from said second mobile antenna during a second portion of said uplink interval; and

wherein said correlation circuitry is capable of measuring changes in said second set of spatial signatures with respect to said first set of spatial signatures to identify said least changing spatial signature.

1           3.    The apparatus as set forth in Claim 2 wherein  
2    said correlation circuitry comprises:

3           a controller;

4           a table coupled to said controller, said table capable  
5    of storing values of said spatial signatures;

6           a first spatial correlator coupled to said controller  
7    and to said table, said first spatial correlator capable of  
8    correlating values of spatial signatures from said first  
9    mobile antenna;

10          a second spatial correlator coupled to said controller  
11   and to said table, said second spatial correlator capable  
12   of correlating values of spatial signatures from said  
13   second mobile antenna;

14          a comparator coupled to said controller and to said  
15   first spatial correlator and to said second spatial  
16   correlator, said comparator capable of comparing  
17   correlation values from said first spatial correlator and  
18   from said second spatial correlator to determine a downlink  
19   beamforming weight vector.

1           4.    The apparatus as set forth in Claim 3 wherein  
2    said table is a 4M by one table capable of storing values  
3    of said spatial signatures, where M is a number of antennas  
4    in said adaptive antenna array.

1           5.    The apparatus as set forth in Claim 4 wherein  
2    said 4M by one table contains:

3           M spatial signatures  $a^1_p$  representing a first set of  
4    spatial signatures obtained from said first mobile antenna;

5           M spatial signatures  $a^2_p$  representing a first set of  
6    spatial signatures obtained from said second mobile  
7    antenna;

8           M spatial signatures  $a^1_c$  representing a second set of  
9    spatial signatures obtained from said first mobile antenna;  
10   and

11          M spatial signatures  $a^2_c$  representing a second set of  
12   spatial signatures obtained from said second mobile  
13   antenna.

1  
1           6.    The apparatus as set forth in Claim 5 wherein  
2    said first spatial correlator calculates a correlation  
3    value  $\rho_1$  between said spatial signatures  $a^1_p$  and said  
4    spatial signatures  $a^1_c$  given by:

$$\rho_1 = \left| (a^1_c) * (a^1_p) \right|$$

5  
6    where the symbol \* represents a process of correlation of  
7    two signals.

1  
2           7.    The apparatus as set forth in Claim 6 wherein  
3    said second spatial correlator calculates a correlation  
4    value  $\rho_2$  between said spatial signatures  $a^2_p$  and said  
5    spatial signatures  $a^2_c$  given by:

$$\rho_2 = \left| (a^2_c) * (a^2_p) \right|$$

6    where the symbol \* represents a process of correlation of  
7    two signals.

1           8.    The apparatus as set forth in Claim 7 wherein  
2    said comparator compares said correlation value  $\rho_1$  and said  
3    correlation value  $\rho_2$ ;

4           wherein said comparator outputs to said controller a  
5    value of zero if said correlation value  $\rho_1$  is greater than  
6    or equal to said correlation value  $\rho_2$ ; and

7           wherein said comparator outputs to said controller a  
8    value of one if said correlation value  $\rho_1$  is less than said  
correlation value  $\rho_2$ .

9           The apparatus as set forth in Claim 8 wherein  
said controller selects said M spatial signatures  $a^1_c$  as  
components of a downlink beamforming weight vector W if  
said output value from said comparator is one; and

5           wherein said controller selects said M spatial  
6    signatures  $a^2_c$  as components of a downlink beamforming  
7    weight vector W if said output value from said comparator  
8    is zero.

1           10. The apparatus as set forth in Claim 9 comprising  
2       a downlink beamformer coupled to said controller, said  
3       downlink beamformer capable of receiving said downlink  
4       beamforming weight vector  $W$  from said controller, and  
5       capable of complex multiplying an incoming complex data  
6       stream  $S$  with said downlink beamforming weight vector  $W$ ,  
7       and capable of outputting a resulting complex data stream  $X$   
8       to transmit portions of  $M$  transceivers associated  
9       respectively with  $M$  antennas of said adaptive antenna  
array.

1           11. For use in wireless network communications system  
2           comprising a base transceiver station having an adaptive  
3           antenna array and a mobile station having a first mobile  
4           antenna and a second mobile antenna, a method for improving  
5           downlink performance of said adaptive antenna array of said  
6           base transceiver station, said method comprising the steps  
7           of:

8           obtaining in a spatial signature estimator associated  
9           with said base transceiver station a spatial signature from  
10          a signal received by said base transceiver station from  
11          said first mobile antenna;

12          obtaining in said spatial signature estimator a  
13          spatial signature from a signal received by said base  
14          transceiver station from said second mobile antenna; and

15          using spatial signatures obtained from said first  
16          mobile antenna and from said second mobile antenna to  
17          identify a least changing spatial signature; and

18          using said least changing spatial signature to obtain  
19          a downlink beamforming weight vector.



1           12. The method as set forth in Claim 11 further  
2 comprising the steps of:

3           obtaining in said spatial signature estimator a first  
4 set of spatial signatures comprising a first spatial  
5 signature from said first mobile antenna and a first  
6 spatial signature from said second mobile antenna during a  
7 first portion of an uplink interval of a time division  
8 duplex slot associated with said first mobile antenna and  
9 said second mobile antenna; and

10           obtaining in said spatial signature estimator a second  
11 set of spatial signatures comprising a second spatial  
12 signature from said first mobile antenna and a second  
13 spatial signature from said second mobile antenna during a  
14 second portion of said uplink interval; and

15           using correlation circuitry to measure changes in said  
16 second set of spatial signatures with respect to said first  
17 set of spatial signatures to identify said least changing  
18 spatial signature.

1           13. The method as set forth in Claim 12 wherein said  
2 correlation circuitry comprises:

3           a controller;

4           a table coupled to said controller, said table capable  
5 of storing values of said spatial signatures;

6           a first spatial correlator coupled to said controller  
7 and to said table, said first spatial correlator capable of  
8 correlating values of spatial signatures from said first  
9 mobile antenna;

10           a second spatial correlator coupled to said controller  
11 and to said table, said second spatial correlator capable  
12 of correlating values of spatial signatures from said  
13 second mobile antenna;

14           a comparator coupled to said controller and to said  
15 first spatial correlator and to said second spatial  
16 correlator, said comparator capable of comparing  
17 correlation values from said first spatial correlator and  
18 from said second spatial correlator to determine a downlink  
19 beamforming weight vector.

1           14. The method as set forth in Claim 13 further  
2 comprising the step of:

3           storing values of said spatial signatures in said  
4 table, wherein said table is a 4M by one table, where M is  
5 a number of antennas in said adaptive antenna array.

1           15. The method as set forth in Claim 14 further  
2 comprising the steps of:

3           storing in said 4M by one table M spatial signatures  
4  $a^1_p$ , representing a first set of spatial signatures obtained  
5 from said first mobile antenna;

6           storing in said 4M by one table M spatial signatures  
7  $a^2_p$ , representing a first set of spatial signatures obtained  
8 from said second mobile antenna;

9           storing in said 4M by one table M spatial signatures  
10  $a^1_c$  representing a second set of spatial signatures obtained  
11 from said first mobile antenna; and

12           storing in said 4M by one M spatial signatures  $a^2_c$   
13 representing a second set of spatial signatures obtained  
14 from said second mobile antenna.

calculating in said first spatial correlator a correlation value  $\rho_1$  between said spatial signatures  $a^1_p$  and said spatial signatures  $a^1_c$  given by:

where the symbol  $*$  represents a process of correlation of two signals.

calculating in said second spatial correlator a correlation value  $\rho_2$  between said spatial signatures  $a^2_p$  and said spatial signatures  $a^2_c$  given by:

where the symbol  $*$  represents a process of correlation of two signals.

1           18.    The method as set forth in Claim 17 further  
2    comprising the steps of:

3            comparing   said   correlation   value    $\rho_1$    and   said  
4    correlation value  $\rho_2$  in said comparator;

5            outputting from said comparator to said controller a  
6    value of zero if said correlation value  $\rho_1$  is greater than  
7    or equal to said correlation value  $\rho_2$ ; and

8            outputting from said comparator to said controller a  
9    value of one if said correlation value  $\rho_1$  is less than said  
10   correlation value  $\rho_2$ .

11           19.   The method as set forth in Claim 18 further  
12   comprising the steps of:

13           selecting in said controller said M spatial signatures  
14    $a^1_c$  as components of a downlink beamforming weight vector W  
15   if said output value from said comparator is one; and

16           selecting in said controller said M spatial signatures  
17    $a^2_c$  as components of a downlink beamforming weight vector W  
18   if said output value from said comparator is zero.

1           20. The method as set forth in Claim 19 further  
2 comprising the steps of:

3           receiving in a downlink beamformer coupled to said  
4 controller said downlink beamforming weight vector  $W$  from  
5 said controller;

6           complex multiplying in said downlink beamformer an  
7 incoming complex data stream  $S$  with said downlink  
8 beamforming weight vector  $W$ ;

9           outputting from said downlink beamformer a resulting  
10 complex data stream  $X$  to transmit portions of  $M$   
11 transceivers associated respectively with  $M$  antennas of  
12 said adaptive antenna array.